4-B
GEOTECHNICAL PROGRESS REPORT: CONVEYANCE

FINAL ENVIRONMENTAL IMPACT STATEMENT

Brightwater Regional Wastewater Treatment System

APPENDICES

Brightwater
TREATMENT SYSTEM

Final

Appendix 4-B
Geotechnical Progress Report: Conveyance

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1.0 INTRODUCTION

King County has prepared a Draft Environmental Impact Statement (Draft EIS) and Final Environmental Impact Statement (Final EIS) on the Brightwater Regional Wastewater Treatment System. The Final EIS is intended to provide decision-makers, regulatory agencies and the public with information regarding the probable significant adverse impacts of the Brightwater proposal and identify alternatives and reasonable mitigation measures.

King County Executive Ron Sims has identified a preferred alternative, which is outlined in the Final EIS. This preferred alternative is for public information only, and is not intended in any way to prejudge the County's final decision, which will be made following the issuance of the Final EIS with accompanying technical appendices, comments on the Draft EIS and responses from King County, and additional supporting information. After issuance of the Final EIS, the King County Executive will select final locations for a treatment plant, marine outfall and associated conveyances.

The County Executive authorized the preparation of a set of Technical Reports, in support of the Final EIS. These reports represent a substantial volume of additional investigation on the identified Brightwater alternatives, as appropriate, to identify probable significant adverse environmental impacts as required by the State Environmental Policy Act (SEPA). The collection of pertinent information and evaluation of impacts and mitigation measures on the Brightwater proposal is an ongoing process. The Final EIS incorporates this updated information and additional analysis of the probable significant adverse environmental impacts of the Brightwater alternatives, along with identification of reasonable mitigation measures. Additional evaluation will continue as part of meeting federal, state and local permitting requirements.

Thus, the readers of this Technical Report should take into account the preliminary nature of the data contained herein, as well as the fact that new information relating to Brightwater may become available as the permit process gets underway. It is released at this time as part of King County's commitment to share information with the public as it is being developed.

1.1 Site and Project Description

The proposed Brightwater conveyance system includes influent and effluent pipelines primarily constructed in tunnels. The system also includes access portals and associated support facilities. The influent pipeline will carry untreated wastewater to the plant for treatment. The effluent pipeline will carry treated wastewater from the plant to Puget Sound for discharge. A separate pipeline will transport treated effluent to the Woodinville and Redmond areas for reuse.

The preferred conveyance system alignment consists of the Route 9 - 195th Street alignment as shown on Figures 1 through 4. The effluent pipeline alignment and primary construction portals are shown on Figures 1 through 3. The influent pipeline alignment and primary construction portals are shown starting on Figure 4 and finishing on Figure 3. The influent and effluent pipelines will be combined in one tunnel from portal 44 to the treatment plant (Figure 3).

Wastewater would flow by gravity through the influent and effluent lines. Alternative pipeline depths within the range of 50 to 400 feet are being considered as shown on Figures 5 through 8. The final pipeline depth interval will be selected during the design phase for the selected alternative.

Several types of permanent facilities would be constructed at primary portal sites. These include hydraulic control structures, a dechlorination facility, and chemical injection / odor control facilities.

1.2 Purpose and Scope

This Geotechnical Progress Report (GPR) describes the procedures and presents the results of the field exploration program and geotechnical laboratory testing. This report addresses all elements of the Brightwater Conveyance project for the preferred alignment, including the effluent pipeline, influent pipeline, portals, marine outfall, and connecting pipelines and structures. The purpose of this report is to provide a summary of current data and data acquisition procedures for inclusion in the FEIS. Since all of the boring logs are currently being edited to reflect new data from on-going laboratory testing, the boring logs or any interpretive profiles are not included.

1.3 Report Layout

This GPR report is divided into six sections, which describe the data acquisition procedures and results: The sections include:

1) Introduction – Description of the project, purpose and scope of this report, and limitations of this report;

2) Subsurface Exploration Program – Land based and over-water exploration procedures and data;

3) Hydrogeologic Testing – Groundwater measurement procedures and data;

4) Geotechnical Laboratory Testing – Soil testing results and procedures;

5) Gas Monitoring - .Gas monitoring procedures used during drilling and after completion of groundwater well installation.

6) References – Standard references cited in this report.

1.4 Limitations

This report has been prepared for the exclusive use of King County Waste Water Treatment Division and its consultants for The Brightwater Conveyance Project only. The data presented in this report are based on subsurface conditions encountered at the time of our study and our experience and engineering judgment. CDM cannot be held responsible for the interpretation by others of the data contained herein.

Within the limitations of scope, schedule, and budget, our services have been performed in a manner consistent with that level of care and skill ordinarily exercised by members of the profession currently practicing under similar conditions in the area. No other warranty, express or implied, is made.

2.0 SUBSURFACE EXPLORATION PROGRAM

The field exploration program for the Brightwater Conveyance project started on January 31, 2003. A total of 58 borings have been completed for the effluent and influent pipeline and tunnel portals. Explorations are planned for connecting pipelines and structures, but have not been started at this time. The locations of completed explorations are shown on Figures 1 through 4.

In-situ testing data include groundwater monitoring and gas measurements. At some locations initial groundwater monitoring data was obtained from observation wells that have not yet been developed. One of the on-going field activities is the development of all observation wells along the alignment and confirmation of the previous groundwater readings. Additional proposed in-situ testing consisting of groundwater pumping tests, slug tests, cone penetrometer testing, pressuremeter testing, and downhole seismic testing has not started at this time.

Over-water explorations completed at this time for the marine outfall portion of the Brightwater Conveyance project include geophysical surveys, and mini cone penetrometer testing. Additional explorations consisting of mini cone penetrometer tests, gravity cores, and overwater borings along the preferred alignment are planned for the summer of 2003.

Laboratory testing has been completed to classify soils and identify geologic units. The majority of the testing has consisted of index tests and geologic tests. More extensive soil testing consisting of additional index testing, geologic testing and strength and deformation testing will be performed once the vertical tunnel alignment has been determined.

The project geodetic (horizontal) datum is the North American Datum of 1983, adjusted for HPGN in 1991 (NAD83/91). All coordinates are based on the Washington North Zone of the State Plane Coordinate System (SPCS83) and are in U.S. Survey Feet.

The Brightwater Project vertical datum is METRO Datum. However, all elevations used for the exploration program are based on the North American Vertical Datum of 1988 (NAVD88) and are in feet. For conversion, METRO Datum = NAVD88 + 96.28 feet. The bathymetric vertical datum is Mean Lower Low Water (MLLW) and all water depths are in feet. For conversion, MLLW = NAVD88 + 2.29 feet, or MLLW = Metro Datum - 93.99 feet.

Borings were originally located in the field using hand-held GPS and the elevations estimated based on locating the coordinates on project aerial mapping. Initially approximately 20 borings were surveyed for location and elevation and these were used to verify the accuracy of this preliminary field location method. Upon completion of the field exploration program all boring locations will be field located by survey.

2.1 Soil Classification System

Soil samples recovered from the borings were classified in general accordance with the American Society for Testing Materials (ASTM) D2488, Standard Recommended Practice for Description of Soils (Visual Manual Method) and ASTM D2487, Standard Test Method for Classification of Soils for Engineering Purposes. Soils are described in accordance with King County WTD procedures. The classification system is summarized on Figure 9.

2.2 Geologic Units and Description

The geologic unit nomenclature used for this project is based on criteria developed by the Seattle-Area Geologic Mapping Program (SGMP) and King County WTD. The list of geologic units used for this project is presented in Table 1. The assigning of a geologic unit to a particular grouping of soil types was based on our interpretation of the depositional environment, stratigraphic relationships, and engineering properties.

2.3 Land Based Explorations

Table 2 provides a summary of the borings, including location, date completed, drilling subcontractor, drilling method or methods, surface elevation and boring depth. All of the explorations were continuously observed by a member of the CDM design team. The following sections provide a description of the drilling and sampling procedures used for this project.

2.3.1 Land Drilling Procedures

Drilling was performed by several contractors using four different drilling methods, including hollow-stem auger, mud rotary, rotosonic coring, and wireline coring. To date all drill rigs used for this project were truck mounted. At some drilling locations due to difficult soil and groundwater conditions a combination of drilling methods was used to advance the boring.

2.3.1.1 Auger Drilling

Hollow-stem auger (HSA) drilling was performed at selected boring locations where the depth of the boring was generally less than 100 ft. The HSA method consists of advancing continuous-flight-augers into the soil by rotation. As the augers are advanced, soil cuttings from the borehole move upward along the exterior flights of the augers to the surface. A plug at the end of the drilling rods is maintained in the lead (lowest) auger section to prevent soil cuttings from entering the hollow-stem of the auger. Samples are obtained by pulling the drill rods from the auger-cased hole, removing the plug from the ends of the rods, attaching the sampler to the end of the rods and lowering the sampler to the bottom of the hole and hammering the sampler into the ground. Drive sampling methods are described in Section 2.3.2.1.

Difficulties were encountered in maintaining hole stability and in obtaining good quality samples because of the high groundwater conditions, artesian conditions and gravels and cobbles. As a result, this method of drilling was abandoned early in the exploration program.

2.3.1.2 Mud-Rotary Drilling

The mud rotary method consists of drilling an approximately 6-inch diameter borehole in the ground using a tricone roller bit and drilling mud (either a bentonite-based or a polymer-based fluid) to wash the soil cuttings from the borehole, cool the bit, and to maintain borehole stability. The tricone bit is used to advance the borehole. Drilling mud is pump from the mud tub at the surface, down the drill rods and out through the bit. The drilling mud carries soil cuttings up the annular space between the drill rods and the borehole wall back to the mud tank at the surface. Cuttings carried by the drilling mud are allowed to settle out in the mud tank and the drilling fluid is recirculated back down the borehole. The borehole is cased if borehole stability becomes a problem. Samples are obtained by pulling the drill rods and drill bit from the hole. At shallow depths, the drill bit at the end of the rods is replaced with a sampler and lowered to the bottom of the hole. At deeper depths, the sampler is attached to a wire line-operated hammer and lowered to the bottom of the hole.

2.3.1.3 Rotosonic Drilling

The rotosonic method consists of advancing a steel casing into the ground by applying high-frequency vibrations to the top of the casing. Down pressure and rotation are also used to advance the casing. Nearly continuous soil samples are obtained. As the casing is advanced, a core of soil enters the 4- or 6-inch outside diameter (O.D.) core barrel. The core barrel is periodically retrieved to the surface and soil samples are extracted from the core barrel by vibrating the contents of the casing into a plastic bag.

2.3.1.4 Wireline Drilling

The wireline method consists of drilling an approximately 6-inch diameter hole in the ground by rotary coring of the soil. This is method utilizes a PQ wireline core system similar to a rock coring system, and a drilling fluid (either a bentonite-based or polymer-based slurry) to wash excess cuttings to the ground surface and maintain hole stability. A continuous soil core sample will generally be obtained throughout the boring depth; however, discrete drive samples may be obtained by removing the inner core barrel and driving a sampler into the undisturbed ground.

2.3.2 Soil Sampling

The following soil sampling procedures were used for this exploration program.

2.3.2.1 Drive Samples

Driven soil samples were obtained at selected depths from the HSA borings and mud rotary borings using a 2.42-inch I.D., 3.25-inch O.D., ring-lined, split-barrel sampler. For shallow sampling depths, the sampler was placed at the end of drill rods and lowered to the bottom of the borehole. The sampler was then driven 18 inches (or a portion thereof) into the relatively undisturbed soil below the bottom of the borehole with either a 300-pound or 140-pound auto-release hammer. At deeper depths, the sampler was attached to either a 300-pound or 140-pound hammer suspended on a wireline and lowered to the bottom of the hole. In all cases these samples are considered to be disturbed samples relative to their quality for laboratory testing.

The number of blows to advance the sampler the last 12 inches (or portion thereof) of the 18-inch drive is recorded on the boring log at the depth the sample was taken. This blow count is not the “standard penetration resistance (N)”, which applies only to a 2-inch O.D., split-spoon sampler attached at the end of drill rods, driven with a 140 pound hammer, but provides a relative indication of soil density or consistency.

2.3.2.2 Thin Wall Tube Sampling

In selected mud rotary and wireline borings, tube samples were obtained using a hydraulically advanced thin-walled sampler, a Pitcher Barrel sampler, or a geo-barrel sampler. The location and types of the tube samples will be identified on the final boring logs.

2.3.2.3 Core Samples

Nearly continuous soil core samples were obtained using the rotosonic drilling and wireline drilling methods. Samples from the rotosonic borings were obtained using vibration and rotating the core barrel Rotosonic drilling results in some disturbance to the core. Observed core recovery in excess of the drilled length was evidence of this disturbance. During drilling of cohesive soils with the rotosonic method, some of the energy of drilling was transmitted into the core as heat, occasionally resulting in hot samples that may not contain representative moisture content. This soil condition was noted on the logs.

2.4 Outfall Explorations

Over-water explorations completed at this time for the marine outfall portion of the Brightwater Conveyance project consist of a bathymetric survey, side scan sonar, sub-bottom profiling, and single channel shallow seismic profiler survey. These geophysical surveys were conducted in two phases from February 25 and 26, 2003 and from April 21 to 22, 2003. The Final Outfall Geophysical Survey report is presented as FEIS Appendix 4C.

The first phase consisted of sidescan sonar imagery, bathymetry, and sub-bottom profile data. The survey area encompassed outfall Zone 7S and included a rectangular area extending about 7,000 ft along the shoreline and extending from the 50-ft water depth seaward for about 7,500 ft.

The second phase of the marine geophysical survey was a high-resolution survey to augment the first phase bathymetric and sub-bottom information. The survey system consisted of a high-resolution echo sounder, a 3.5 kHz sub-bottom profiler system, a shallow seismic profiler system and an integrated navigation and positioning system.

3.0 HYDROGEOLOGIC TESTING

Standpipe and vibrating-wire pressure transducer piezometers (VWPs) were installed in boreholes along the alignment to measure groundwater levels, to be used in conjunction with slug and aquifer tests, and to collect groundwater quality data. Slug test and aquifer testing has not been started at this time. This section details the procedures followed in installing these piezometers in addition to the monitoring and testing data collected from the installations.

The following subsections present the general steps followed for installation of standpipes and VWPs, and development of observation wells. These methods are in general accordance with Washington Administrative Code 173-160, which regulates the installation of wells.

3.1 Observation Wells and Vibrating Wire Piezometers

Piezometer installations consist of both cased standpipes and vibrating wire transducers. Tables 3a and 3b summarize piezometer installation locations and depths. The number of piezometers installed varies by location from none to three per borehole. Nested installations never included more than a single standpipe piezometer, but at specific locations consisted of multiple grouted-in-place vibrating wire transducers.

3.1.1 Standpipe Piezometers

Standpipe piezometers were consistently constructed using 2-inch-diameter PVC with machine-slotted screen (both schedule 40 and schedule 80). Screen sections are 10 feet in length, except in one instance, where 20 feet was used to improve the connection between the well and the adjacent water-bearing soils. When a drilled borehole reached its target depth, drilling fluid (if used) was flushed from the borehole with clean water. As needed based on targeted piezometer depth, bentonite chips were then poured down the borehole to abandon the bottom of the borehole to a depth of 2 to 5 feet below the bottom of the screen. Two-twelve silica sand was then poured onto the top of the chips until the bottom of the screen target was reached. A threaded end cap was attached to the bottom of the screen, which was then lowered down the borehole attached to 20-foot-lengths of blank riser. Sand was then poured slowly around the PVC to extend the filter pack 2 to 5 feet above the top of the screen. A bentonite grout/cement mix was then tremied down on top of a roughly 2-foot layer of bentonite chips used to seal off the filter pack. After the borehole was grouted to surface, the PVC was cut to ground level and covered with a slip cap before a monument was installed.

3.1.2 Vibrating Wire Piezometers

Vibrating wire pressure transducer piezometers were installed for hydraulic monitoring, typically in areas with fine-grained soil or potential flowing artesian conditions. Each VWP installation began with the field calibration of the instrument. When one or two VWPs were installed in a borehole without a standpipe, the VWPs were taped to a 1-inch-diameter schedule 10 tremie pipe to secure their depth in the well. The tremie pipe was then lowered down the hole and the well was grouted from bottom to top through the tremie pipe. When VWPs were installed above the screened interval of a standpipe piezometer, the instruments were taped directly to the outside of the 2-inch-diameter PVC and lowered into place.

3.2 Well Development

All standpipe piezometers are being developed to remove sediment and residual drilling fluid from the PVC and filter pack and to improve hydraulic connection with the adjacent formation. Development of each well is presently being performed by the driller who installed the well and under the observation of a CDM design team geotechnical engineer or geologist. This procedure will continue for all wells installed for this project. When particularly dirty wells are encountered, a WaTerra foot-valve pump may be used to remove accumulated sediment from the well casing. Bleach will be poured down the standpipe and allowed to react for a period of 24 hours in cases where polymer drill fluid remains in the well. In holes with minor sediment accumulations, air jetting or a submersible pump may be used to purge the casing. Generally, a minimum of three casing volumes of water will be removed from each standpipe, or until conductivity, turbidity, temperature and pH stabilize (+/- 10%). Purge water will be controlled at the wellhead and, if allowable, will be discharged to a nearby sanitary sewer or removed in secure drums.

3.3 Water Level Monitoring

Water level monitoring is performed either by continuous recording using electronic data loggers or by scheduled manual measurements. All completed pre-design piezometers in addition to piezometers completed at the exploration locations for this program are included in this monitoring program. Water level data is summarized in Tables 3a and 3b.

Rounds of manual measurements were made approximately every two weeks. These data were collected to assess groundwater head distribution and to understand long-term groundwater variations and trends. Methane and barometric pressure readings were also recorded at standpipes in conjunction with the manual measurements.

As of June 10, 2003, 26 data loggers were in use. Each data logger was left in-place for a maximum duration of two weeks to record water pressures every 15 minutes. In situations where it was advantageous to have near-continuous data from a standpipe, a VWP was submerged below the water surface with a data logger attached to record measurements. At the on-set of monitoring, particular attention was given to the western-most wells in an effort to better understand hydraulic head beneath the upland area in addition to the degree of hydraulic connection between water-bearing zones and tidal fluctuations in Puget Sound.

4.0 GEOTECHNICAL LABORATORY TESTING

Geotechnical laboratory testing was performed on selected samples obtained from the borings. Current laboratory testing included index tests to classify soil into similar geologic groups and to characterize the engineering properties of each geologic unit. The following sections describe the geotechnical laboratory testing program completed to date.

4.1 Index Tests

Classification and index testing was completed on selected samples. Index testing included visual classification, moisture content, unit weight, grain size distribution, and Atterberg limits tests. The following provides a brief description of the index testing program. Results of the index testing are summarized in Table 4.

4.1.1 Water Content

Water contents were determined on selected samples for the explorations and were completed in accordance with ASTM D 2216-98, Test Method for Laboratory Determination of Water Content of Soil and Rock.

4.1.2 Unit Weight

The moist and dry unit weight of was determined for selected drive samples from the borings in general accordance with ASTM D2937-94, Standard Test method for Density of Soil in place by the Drive Cylinder Method, modified for a ring sampler. The physical dimensions of the soil sample were measured, weighed, and the moist unit weight calculated. The sample was then oven dried and the water content was determined in accordance with ASTM D 2216-98, and the dry unit weight was calculated.

4.1.3 Grain Size Distribution

Grain size distribution of selected samples from the borings was determined in general accordance with ASTM D 422-63 (reapproved 1998), Standard Test Method for Particle-Size Analyses of Soils.

4.1.4 Atterberg Limits

Soil plasticity was determined for selected fine-grained samples from the borings by performing Atterberg Limit tests. The tests were performed in general accordance with ASTM D 4318-98, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. Atterberg limits include the Liquid Limit (LL), the Plastic Limit (PL) and the Plasticity Index (PI=LL-PL).

4.2 Strength Testing

Unconfined compression testing was completed on selected samples form the borings to determine the strength of selected soil samples. The tests were performed on selected, relatively, undisturbed fine-grained soil from the borings. Testing was in general accordance with ASTM D 2166-98, Unconfined Compressive Strength of Cohesive Soil. The sample was placed in a deformation-controlled load frame, with top and bottom platens. The sample was compressed at a constant rate of 0.1 to 0.02 inches per minute while measuring the applied load with a proving ring. The UC strengths are summarized in Table 5.

5.0 GAS MEASUREMENTS

Field screening was performed to determine if methane was present in the boreholes during drilling, prior to well installation, and after well installation. The results are summarized in Table 6.

5.1 During Drilling

The following procedures were used to monitor methane and hydrogen sulfide gas.

- At the end of the day, seal the casing with a casing plug (i.e., sewer plug) or, use a cutoff Tedlar bag with sample port built in to the bag.
- At the beginning of the following day, have 4-gas meter running and calibrated prior to removing the plug or piercing the film. Place intake hose into casing and monitor levels of methane, hydrogen sulfide, carbon dioxide, and oxygen for a minimum of two minutes or until levels have stabilized. Record levels on the Field Screening Data Sheet (attached).
- Continue to monitor periodically while in zones of suspected methane and/or hydrogen sulfide sources (organic rich recent alluvial deposits and Pre-Vashon interglacial units). Conduct monitoring at casing breaks during drilling.
- Collect samples of granular and/or organic-rich soils in a Ziploc bag to monitor headspace. Select samples that are permeable or have a high organic content and can be broken apart in the sealed Ziploc bag. Wait 10 minutes for gases to diffuse into the bag headspace and measure with the 4-gas meter.
- Periodically monitor the drilling fluid returns for odor (if applicable). If an indication of gas is present, monitor using the 4-gas meter.

5.2 Prior to Well Installation

Prior to well installation, the headspace inside of the casing was monitored using the 4-gas meter. Cover the hole as described in step one above, for about 5 minutes and then proceed to monitor and record results as described in step two above.

5.3 Completed Observation Wells

Gas monitoring was conducted at the time water levels were measured. Gas concentrations were measured first upon arrival by connecting the hose, opening the sampling port on well cap and recording measurements on to the Field Screening Data Sheet. Monitoring will continue at each well as long as methane is detected, or for a minimum of 4 consecutive rounds of measurements if no methane has been detected.

Wells that produce positive methane results during monitoring will be sampled using a passive diffusion bag sampler (PDBS). The PDBS is a low-density polyethylene semi-permeable membrane, filled with deionized water, which can be placed into the well for a period of two to three weeks. Volatile organic compounds in groundwater diffuse across the membrane and dissolve.

6.0 REFERENCES

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- D 2488-00, Standard Practice for Description and Identification of Soils (Visual Manual Procedure).
- D2216-98, Test Method for Laboratory Determination of Water Content of Soil and Rock.
- D2937-94, Standard Test Method for Density of Soil In Place by the Drive Cylinder Method.
- D422-63, Standard Test Method for Particle-Size Analyses of Soils.
- D4318-98, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
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Washington Administrative Code 173-160.

Table 1: Description of Geologic Units in the Brightwater Area

Symbol	Unit Description
Postglacial Deposits	
m	Modified land (Holocene) - Fill, or extensively graded natural deposits that obscure or substantially alter the original deposit. Locally subdivided into:
f	Fill - Fill of substantial areal extent or thickness
gr	Graded - Extensively graded
Qal	Alluvium (Holocene) - Moderately sorted deposits of gravel, sand, and silt along the floodplains of lowland streams and rivers. May include deposits of late-Fraser glaciation age that cannot unequivocally be assigned a pre-Holocene origin
Qb	Beach deposits (Holocene) – Loose sand and gravel deposited by wave action. Narrow beaches not delineated
Qe	Estuarine deposits (Holocene) – Loose interbedded silt and sand deposited at the mouth of a stream. Woody debris, marsh plants, and shells common
Qtf	Tideflat deposits (Holocene) – Loose and soft sand and silt deposited by wave action. Narrow tideflats not delineated
Qmw	Mass-wastage deposits (Holocene) - Colluvium, soil, and landslide debris that has indistinct morphology; mapped where sufficiently thick and continuous to obscure underlying material. Numerous unmapped areas of mass-wastage deposits also occur. Deposits, both mapped and unmapped, may include discrete landslides 1-10 m in lateral extent
Qls	Landslide deposits (Holocene) - Diamicts composed of broken to internally coherent surficial deposits derived from upslope. Numerous unmapped areas of landslide deposits occur along the steep slopes and coastal bluffs, particularly where coarse-grained deposits (units Qva, Qpogf, and Qpfnf) overlie fine-grained deposits (particularly units Qvlc, Qpfnl, Qpogl, and Qpogm)
Ql	Lake Deposits (Holocene) – Sand, silt, and clay in closed depressions and lake bottoms
Qw	Wetland and marsh deposits (Holocene) - Peat and alluvium, poorly drained and intermittently wet. Areas grade into unit Qyal and Qoal
Qp	Peat deposits (Holocene) - Soft peat and organic-rich sediment, poorly drained, former wetlands, subsurface version of Qw

Table 1: Description of Geologic Units in the Brightwater Area (continued)

Symbol	Unit Description
Glacial Deposits of Fraser Glaciation Age	
Qv	Deposits of the Vashon stade of the Fraser glaciation of Armstrong and others (1965) (Pleistocene) - Consists of:
Qvr	Recessional outwash deposits - Stratified sand and gravel, moderately sorted to well sorted, and less common silty sand and silt. Exposed primarily in broad outwash channels, which generally carried glacial meltwater that drained southward away from the ice margin during retreat. Deposits less than about 1 m thick not shown on map. Typically contains northern provenance lithologies. Locally subdivided into:
Qvrf	Recessional fluvial deposits - Predominantly sand and gravel
Qvrl	Recessional lacustrine deposits – Fine-grained sand, silt, and clay deposited in slack water environments during ice recession
Qvi	Ice-contact deposits - Deposits similar in texture to unit Qvr but locally containing a much higher percentage of silt intermixed with lenses and pods of sand, gravel and till. Normally consolidated. Commonly with steeply dipping beds
Qvit	Subaerial till – Diamict, similar to Qvt, but has not been overridden by the Vashon glacier and therefore is not as compact as Qvt. This unit tends to be discontinuous over short lateral distances and is often gradational with Qvi and Qvr
Qvt	Subglacial till - Basal till. Compact diamict containing subrounded to well-rounded clasts, glacially transported and deposited. Generally forms an undulating surface. A few meters to a few tens of meters thick. Also found sporadically within areas mapped as unit Qvi. Subglacial till may be lodgement, or subglacial melt-out in origin; but in any case has been overridden. Locally subdivided into:
Qvtl	Subglacial lodgment till - Dense, overridden, homogenous, matrix-supported gravelly, sandy silt with cobbles. Interlayed or intermixed with sand, silt, and/or gravel lenses.
Qvtm	Subglacial meltout till - Dense, overridden, heterogeneous deposit of till interlayed or intermixed with sand, silt, and/or gravel lenses. Till tends to be sandy rather than silty
Qva	Advance outwash deposits - Well-bedded sand and gravel deposited by streams and rivers issuing from the front of the advancing ice sheet. Generally unoxidized; almost devoid of silt or clay, except near the base of the unit where Qva is sometimes transitional with Qvlc when present
Qvlc	Lawton Clay - Laminated to massive silt, clayey silt, and silty clay deposited in lowland or proglacial lakes. Marks transition from nonglacial to glacial time although unequivocal evidence for glacial or nonglacial origin may be absent. May include top of Qob where conformable

Table 1: Description of Geologic Units in the Brightwater Area (continued)

Symbol	Unit Description
Pre-Fraser Glacial and Non-glacial Deposits of Known Age	
Qob	Olympia beds (Pleistocene) - Sand, silt (locally organic-rich), peat, and tephra, thinly interbedded. May contain diatomaceous layers. Discontinuous. Sand and gravel clast lithology varies depending on source area, from volcanic to reworked northern lithologies
Qpd	Possession Drift (Pleistocene)
Qwb	Whidbey Formation (Pleistocene)
Qdb	Double Bluff Drift (Pleistocene)
Pre-Fraser Sedimentary Deposits of Unknown Origin	
Qpf	Sedimentary deposits of pre-Fraser glaciation age (Pleistocene) - Unoxidized to moderately oxidized sand and gravel, lacustrine sediments, and unoxidized to strongly oxidized diamict composed of silty matrix and rounded gravel clasts. Glacial or nonglacial origin uncertain. Locally subdivided into:
Qpfl	Lacustrine deposits of pre-Fraser glaciation age (Pleistocene) - Origin indeterminable
Qpff	Fluvial deposits of pre-Fraser glaciation age (Pleistocene) – Origin indeterminable
Qpon	Nonglacial sedimentary deposits of pre-Olympia interglaciation age (Pleistocene)
Pre-Fraser Nonglacial Deposits	
Qpfn	Nonglacial sedimentary deposits of pre-Fraser glaciation age (Pleistocene) - Sediment of inferred nonglacial origin, based on the presence of peat, paleosols, and tephra layers; or a southern Cascade Range provenance for sedimentary clasts. Further subdivision by age not yet established. Locally subdivided into:
Qpfnl	Lacustrine deposits - Deposits similar in texture to Ql. May include interbeds of Qpfnf, Qpfnp, and organic-rich sediments
Qpfnf	Fluvial deposits – Deposits similar in texture to Qal. May include interbeds of Qpfnl and scattered to abundant organics
Qpfnb	Beach deposits – Deposits similar in texture to Qb.
Qpfnp	Wetland deposits – Deposits similar in texture to Qp. May include interbedded fluvial and lacustrine deposits

Table 1: Description of Geologic Units in the Brightwater Area (continued)

Symbol	Unit Description
Pre-Fraser Sedimentary Deposits of Unknown Origin (Continued)	
Pre-Olympia Glacial Deposits	
Qpog	Glacial sedimentary deposits of pre-Olympia interglaciation age (Pleistocene) - Sediment of inferred glacial (northern) origin, based on the presence of clasts or mineral grains requiring southward ice-sheet transport. Locally subdivided into:
Qpogm	Glaciomarine drift - Diamict of highly variable composition, similar in texture to Qvt and Qvlc, deposited in a marine environment from floating ice and debris flows from the ice or recently deposited drift, may contain lenses of glaciofluvial deposits and scattered marine shells
Qpogt	Glacial till - Similar in texture to Qvt, Qvtl, and Qvtm
Qpogf	Glacial outwash – Similar in texture to Qva and Qvrf. May occur as thin lenses or interbeds within other glacial deposits
Qpogl	Glaciolacustrine deposits - Similar in texture to Qvlc
Qpogd	Glacial diamict deposits – Matrix supported diamict containing variable amounts of subrounded to well-rounded sand and gravel clasts, glacially transported and deposited in a fine-grained matrix. May occur as lenses within glaciomarine or glaciolacustrine deposits

Table 2: Summary of Borings

Boring Number	Date Completed	Boring Depth (feet)	Ground Surface Elevation (feet)[a]	Northing (feet)[b]	Easting (feet)[b]	Drilling Contractor[c]	Drilling Method[d]				GW Monitoring[e]	
							HS	MR	WL	RS	OW	VWP
E-101	03/20/2003	140.0	35.0	287,665	1,256,910	CDI		X		X	X	
E-102	03/06/2003	270.0	195.0	287,620	1,258,050	GDI		X			X	X
E-103	03/15/2003	380.0	307.0	287,570	1,259,950	GDI		X	X		X	X
E-104	04/15/2003	361.5	310.0	287,302	1,262,140	CDI				X		X
E-105	03/03/2003	535.0	454.0	287,354	1,264,060	CDI				X		
E-106	04/22/2003	566.0	486.0	287,270	1,266,094	CDI			X		X	
E-107	03/24/2003	548.0	453.0	287,302	1,268,050	CDI			X			X
E-110	04/04/2003	436.0	348.0	286,935	1,274,170	CDI			X		X	X
E-111	03/10/2003	385.0	298.0	285,951	1,277,630	CDI				X	X	X
E-112	02/28/2003	297.5	215.0	284,594	1,279,060	CDI				X	X	X
E-113	03/17/2003	277.0	198.0	284,411	1,281,040	CDI				X		X
E-114	02/24/2003	374.0	296.0	284,375	1,282,590	GDI		X			X	X
E-115	02/25/2003	447.0	526.0	284,402	1,285,250	CDI				X		
E-116	02/18/2003	305.0	229.0	284,351	1,287,950	CDI				X	X	X
E-117	02/24/2003	341.0	271.0	283,937	1,291,180	CDI				X	X	X
E-118	02/08/2003	177.5	107.0	284,071	1,292,310	CDI				X	X	X
E-119	02/10/2003	137.5	71.0	283,873	1,294,780	CDI				X		X
E-120	02/03/2003	133.5	67.0	283,829	1,296,040	CDI	X				X	X
E-121	04/02/2003	329.0	267.0	283,891	1,299,316	GDI		X			X	X
E-122	04/02/2003	167.5	107.0	283,565	1,301,567	CDI				X		X
E-123	03/26/2003	285.8	226.0	283,564	1,303,259	GDI					X	X
E-124	03/28/2003	346.0	289.0	283,440	1,304,620	CDI		X	X			
E-125	04/03/2003	116.0	62.0	283,592	1,306,600	CDI				X		X

Table 2: Summary of Borings (continued)

Boring Number	Date Completed	Boring Depth (feet)	Ground Surface Elevation (feet)[a]	Northing (feet)[b]	Easting (feet)[b]	Drilling Contractor[c]	Drilling Method[d]				GW Monitoring[e]	
							HS	MR	WL	RS	OW	VWP
E-126	03/26/3003	86.5	30.0	283,449	1,309,290	GDI					X	X
E-201	04/22/2003	242.0	166.4	287,552	1,257,758	CDI				X	X	
E-202	05/02/2003	361.0	304.7	287,747	1,259,559	GDI		X			X	
E-203	04/28/2003	360.0	298.0	287,457	1,261,560	GDI		X			X	X
E-204	05/02/2003	475.0	423.2	287,450	1,263,071	CDI			X			X
E-206	05/06/2003	493.0	480.0	287,120	1,267,325	CDI			X		X	X
E-208	05/06/2003	425.0	358.0	287,222	1,270,587	CDI			X		X	X
E-210	05/15/2003	340.0	307.8	287,264	1,275,617	CDI		X	X			X
E-212	04/28/2003	315.0	269.1	285,118	1,278,053	CDI				X		X
E-213	04/29/2003	278.0	227.2	284,370	1,279,990	CDI				X		X
E-215	04/10/2003	361.0	314.4	284,020	1,286,617	CDI				X		X
E-216	04/10/2003	338.0	294.4	283,937	1,289,596	CDI				X	X	X
E-217	04/24/2003	310.0	322.0	283,916	1,290,354	CDI			X		X	
E-218	04/16/2003	110.0	69.3	283,858	1,294,034	CDI				X	X	
E-219	05/19/2003	320.0	264.4	283,906	1,298,111	CDI		X	X		X	
E-220	05/05/2003	290.0	234.7	283,888	1,299,977	CDI				X	X	
E-224	05/12/2003	100.0	33.4	283,618	1,308,052	GDI		X			X	
E-303	05/30/2003	160.0	189.0	284,291	1,281,409	CDI				X		X
E-304	05/14/2003	295.0	243.6	284,243	1,282,100	CDI				X		X
E-323	05/13/2003	330.0	272.6	283,800	1,298,604	CDI			X			
E-339	05/14/2003	270.0	200.1	283,266	1,312,794	CSI		X	X			X
E-340	05/22/2003	240.0	168.5	283,254	1,313,340	CDI		X	X			
E-341	05/27/2003	220.0	152.5	283,241	1,313,657	CDI			X		X	

Table 2: Summary of Borings (continued)

Boring Number	Date Completed	Boring Depth (feet)	Ground Surface Elevation (feet)[a]	Northing (feet)[b]	Easting (feet)[b]	Drilling Contractor[c]	Drilling Method[d]				GW Monitoring[e]	
							HS	MR	WL	RS	OW	VWP
E-343	05/10/2003	180.0	114.9	283,279	1,314,600	CDI				X	X	
E-349	05/07/2003	200.0	135.4	285,443	1,315,649	CDI				X	X	
E-362	05/14/2003	105.0	60.0	280,256	1,296,061	GDI		X			X	
E-363	05/22/2003	110.0	60.5	281,172	1,296,011	GDI		X			X	
E-364	05/21/2003	115.0	65.1	282,275	1,296,148	GDI		X			X	
N-153	02/05/2003	89.5	32.0	279,804	1,291,340	CDI	X				X	
N-154	02/07/2003	115.6	52.8	278,662	1,296,030	CDI	X					X
N-253	05/08/2003	76.5	38.7	279,372	1,292,580	GDI		X			X	
N-254	05/09/2003	76.0	34.0	278,892	1,294,419	GDI		X			X	
N-255	05/13/2003	105.0	57.0	279,887	1,296,046	GDI		X			X	
N-256	05/15/2003	105.0	57.1	280,672	1,295,992	GDI		X				X
N-257	05/16/2003	115.0	65.0	281,760	1,296,115	GDI		X			X	
N-258	05/19/2003	120.0	66.1	282,666	1,296,155	GDI		X				X

Notes:
a) Vertical datum = NAVD 88, Feet.
b) Horizontal datum = NAD83/91, Washington North Zone, U.S. Survey Feet.
c) CDI = Cascade Drilling, Inc.; GDI = Gregory Drilling, Inc., CSI = Crux Subsurface Inc.
d) HS = Hollow-Stem Auger, MR = Mud Rotary, WL = Wireline, RS = Rotosonic
e) OW = Observation Well, VWP = Vibrating Wire Piezometer

Table 3a: Summary of Piezometer Installation and Water Level Data

Boring Number	Ground Surface Elev. (ft)	VWP Depth (ft)	VWP Elev. (ft)	Date of Water Level Reading											Groundwater Range		
				2/3/03	3/10/03	3/27/03	3/28/03	4/1/03	4/8/03	4/9/03	4/22/03	5/6/03	5/9/03	5/20/03	Lowest Elev. (ft)	Highest Elev. (ft)	Range (ft)
E-102	194.8	260	-65.2		8.5	8.3	8.2		8.5		8.5	6.2		5.6	5.6	8.5	3.0
E-103	307.0	153	154								253.8	254.0		254.3	253.8	254.3	0.5
E-104 (S)	304.9	275	29.9								72.6	72.6		72.7	72.6	72.7	0.1
E-104 (D)	304.9	361	-56.1								16.5	13.8		12.5	12.5	16.5	4.0
E-107 (S)	452.6	371	81.6			228.7	228.7		228.3		228.3	227.8		227.9	227.8	228.7	0.9
E-107 (D)	452.6	511	-58.4			230.1	229.7		229.0		228.7	228.3		228.2	228.2	230.1	1.9
E-110 (S)	348.1	319	29.1								201.7	201.1		201.0	201.0	201.7	0.7
E-110 (D)	348.1	393	-44.9								177.5	176.8		176.6	176.6	177.5	0.9
E-111	298.1	130	168.1			263.0	263.1		262.8		262.8	262.8		262.9	262.8	263.1	0.3
E-112	214.7	255	-40.3		211.0	209.4		208.4	208.3		207.7	207.4		207.2	207.2	211.0	3.9
E-113 (S)	198.4	78	120.4			222.7		221.8	222.2		221.7	221.7			221.7	222.7	1.0
E-113 (D)	198.4	179	19.4			204.6		203.9	204.1		203.8	203.6			203.6	204.6	1.0
E-114	296.1	332.0	-35.9		206.6	206.8			206.3		206.1	206.1		206.2	206.1	206.8	0.7
E-116	229.4	68.0	161.4		219.3	221.1			220.5		220.1	219.5		219.0	219.0	221.1	2.2
E-117	270.9	210.5	60.4		137.2	137.8			137.6		137.6	137.7		137.8	137.2	137.8	0.7
E-118	107.2	140.0	-32.8	105.3	123.3	124.1			123.7		123.6	123.5		123.5	105.3	124.1	18.9
E-119 (S)	71.1	71.0	0.1					79.0	79.2		78.8	78.7		78.6	78.6	79.2	0.6
E-119 (D)	71.1	117.0	-45.9					85.5	85.9		85.6	85.7		85.6	85.5	85.9	0.3
E-120	66.7	64.5	2.2		68.1	69.2		68.5	68.7		68.4	68.2		68.3	68.1	69.2	1.1
E-121	266.9	161	105.9						184.8		185.1	185.2		185.5	184.8	185.5	0.7
E-122 (S)	115.0	58	57						135.3		127.2	121.3		119.7	119.7	135.3	15.7
E-122 (D)	115.0	140	-25						117.3		117.8	117.2		116.6	116.6	117.8	1.2
E-123	225.7	246	-20.3											188.5	188.5	188.5	NA
E-125 (S)	62.0	25	37										48.1	48.0	48.0	48.1	0.1
E-125 (D)	62.0	78	-16										56.3	56.9	56.3	56.9	0.5
E-126	34.0	74	-40						21.7		21.6	21.8		22.3	21.6	22.3	0.7
E-130	227.3	288.0	-60.7		134.8		135.3			134.9	134.4	134.3			134.3	135.3	1.1

Table 3a: Summary of Piezometer Installation and Water Level Data (continued)

Boring Number	Ground Surface Elev. (ft)	VWP Depth (ft)	VWP Elev. (ft)	Date of Water Level Reading											Groundwater Range		
				2/3/03	3/10/03	3/27/03	3/28/03	4/1/03	4/8/03	4/9/03	4/22/03	5/6/03	5/9/03	5/20/03	Lowest Elev. (ft)	Highest Elev. (ft)	Range (ft)
E-203	298.0		298.0									3.8		2.8	2.8	3.8	1.0
E-204	423.2		423.2									70.2			70.2	70.2	NA
E-206	480.1		480.1											218.8	218.8	218.8	NA
E-208	357.6		357.6											146.0	146.0	146.0	NA
E-210 (S)	306.5	197	109.5											247.1	247.1	247.1	NA
E-210 (D)	306.5	327	-20.5											154.0	154.0	154.0	NA
E-212	269.1	192	77.1									262.0		364.1	262.0	364.1	102.2
E-213	227.2	85	142.2									237.4		236.6	236.6	237.4	0.8
E-215 (S)	314.4		314.4								230.7	224.3		231.0	224.3	231.0	6.7
E-215 (D)	314.4		314.4								163.7	169.4		162.7	162.7	169.4	6.8
E-216	294.4		294.4								121.9	121.9		121.9	121.9	121.9	0.0
E-304 (S)	243.6													245.4	245.4	245.4	NA
E-304 (D)														208.3	208.3	208.3	NA
E-339 (S)	200.0													75.2	75.2	75.2	NA
E-339 (D)														106.5	106.5	106.5	NA
N-152	70.8	65	5.8		58.1	59.1			58.6		58.6	58.4		58.2	58.1	59.1	1.1
N-154	52.8	115	-62.2		37.4	38.4			37.8		37.3	37.1			37.1	38.4	1.3
N-256	57.1		57.145											37.2	37.2	37.2	NA
N-258	66.1		66.138											66.9	66.9	66.9	NA

(S) Shallower Installation

(D) Deeper Installation

Table 3b: Summary of Well Installation and Water Level Data

Boring Number	Ground Surface Elev. (ft)	Depth to Bottom of Screen (ft)	Date of Water Level Reading										Groundwater Range		
			3/3/03	3/10/03	3/27/03	3/28/03	4/1/03	4/8/03	4/9/03	4/22/03	5/6/03	5/20/03	Lowest Elev. (ft)	Highest Elev. (ft)	Range (ft)
E-101	35.0	131				8.4					7.7	5.6	5.6	8.4	2.8
E-102	194.8	195				59.7		60.0		60.2	60.1	60.2	59.7	60.2	0.5
E-103	307.0	340								122.3	104.3	94.3	94.3	122.3	28.0
E-106	485.5	429									156.1	157.1	156.1	157.1	1.0
E-110	348.1	200								249.7	245.2		245.2	249.7	4.5
E-111	298.1	353						174.7		177.0	177.3	177.2	174.7	177.3	2.6
E-112	214.7	95					217.9	223.9		221.6		222.4	217.9	223.9	6.0
E-114	296.1	190	259.5	255.0	262.3			257.8		256.0	255.3	255.3	255.0	262.3	7.3
E-116	229.4	243.5	124.1		124.4			124.8		124.8	124.9	124.9	124.1	124.9	0.8
E-117	270.9	282.5			135.9			136.1		136.4	136.4	136.4	135.9	136.4	0.5
E-118	107.2	97			107.2							107.2	107.2	107.2	NA
E-120	66.7	132.5	66.7				69.5						66.7	69.5	2.8
E-121	266.9	281								117.3	117.3	117.1	117.1	117.3	0.3
E-123	225.7	126										143.7	143.7	143.7	NA
E-126	34.0	30								27.6	27.6	27.5	27.5	27.6	0.1
E-129	260.4	285			130.5				130.9	130.2	130.1	130.4	130.1	130.9	0.8
E-130	227.3	160	148.3									-	148.3	148.3	NA
E-201	166.5	235										8.3	8.3	8.3	NA
E-202	309.1	340										33.0	33.0	33.0	NA
E-203	298.0	133									269.7	269.2	269.2	269.7	0.5
E-206	471.8	406										248.8	248.8	248.8	NA
E-208	357.6	252										225.7	225.7	225.7	NA

Table 3b: Summary of Well Installation and Water Level Data (continued)

Boring Number	Ground Surface Elev. (ft)	Depth to Bottom of Screen (ft)	Date of Water Level Reading										Groundwater Range		
			3/3/03	3/10/03	3/27/03	3/28/03	4/1/03	4/8/03	4/9/03	4/22/03	5/6/03	5/20/03	Lowest Elev. (ft)	Highest Elev. (ft)	Range (ft)
E-216	297.0	222								141.0	141.3	141.0	141.0	141.3	0.4
E-217	322.6	290										244.4		244.4	244.4
E-218	63.9	89								79.4		79.4	79.4	79.4	NA
E-219	264.4	240										193.7	193.7	193.7	NA
E-220	234.7	243										119.0	119.0	119.0	NA
E-343	114.9	69										163.2	163.2	163.2	NA
E-349	135.4	75										122.1	122.1	122.1	NA
E-362	60.0	90										44.9	44.9	44.9	NA
N-153	35.5	89.5	25.3		26.0			26.1			26.2	26.1	25.3	26.2	0.9
N-253	38.7	48										21.8	21.8	21.8	NA
N-254	34.0	44										19.3	19.3	19.3	NA

Table 4: Summary of Index Testing Results

Boring Number	Top Depth (feet)	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)	% Gravel	% Sand	% Fines	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index PI
E-101	20	18.7			3.3	86.2	10.5			
E-101	40				30	60	10			
E-101	55	23.3					41.5			
E-101	70	22.3					32.6			
E-101	80	8.3			58.9	38.1	3			
E-101	107.1	11.1			33.9	59.8	6.4			
E-101	139	13.4			3.5	84.9	11.6			
E-102	190	17.9			1.7	88.7	9.6			
E-102	225	16.9			0.8	87.5	11.7			
E-102	235	22.4					55.7			
E-103	160	25.5					82.9			
E-103	325	10			4.1	87.2	8.7			
E-103	361	24.5					72.7			
E-104	231	26.5						47.9	29.2	18.7
E-105	324	32.1						50.3	26.5	23.8
E-105	351	21.9						36.5	28.9	7.6
E-105	367	25.3								
E-105	383	34						77.7	32.2	45.5
E-105	404	21.4								
E-105	413	12.9					50			
E-105	425	17.9			0.3	52.7	47			
E-105	431	16.3					48.3			
E-105	461	14.7			0.4	87.3	12.3			
E-105	502	17.6			0.5	78.8	20.8			
E-107	335	35.1						68.6	33.9	34.7
E-107	353	16.7						28.1	20.6	7.5
E-107	380	19.7			0.9	92.4	6.7			
E-107	382	20.3			0	28.7	71.3			
E-107	389	19.4								
E-107	398.5	17.5			0.6	92	7.4			
E-107	434	18.1					7.1			
E-107	478	20.6			0	93.8	6.2			
E-107	508	18.3			0	87.9	12.1			
E-107	541.5	20.9			0	96.6	3.4			
E-110	218	31.9					85.2			
E-110	229	26.8						51.8	26.2	25.6
E-110	260	13.6	128.8	146.3						
E-110	287	31.5						45.8	22.7	23.1
E-110	315	34.3								
E-110	318.5	33.4								
E-110	322	20.8								
E-111	80.5	21.4								
E-111	131.5	19.7								

Table 4: Summary of Index Testing Results (continued)

Boring Number	Top Depth (feet)	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)	% Gravel	% Sand	% Fines	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index PI
E-111	137	12.2								
E-111	233	29.1								
E-111	322.5	35.2								
E-112	33.5	28.4								
E-112	35	21.2								
E-112	45	20.9								
E-112	61	26								
E-112	65	18.6								
E-112	71	26.8								
E-112	75	18.2								
E-112	81.5	27.7								
E-112	85	0.6								
E-112	86	12								
E-112	95	8.4								
E-112	98.5	11.7								
E-112	100	13.2								
E-112	110	14.4								
E-112	120	12.8								
E-112	125	14.2						72.5	27.2	45.3
E-112	131	10								
E-112	135	12.4								
E-112	140	8.8								
E-112	140.1	21.7								
E-112	140.6	12.8								
E-112	145	10.3								
E-112	146.5	30.9								
E-112	150	9.2								
E-112	155	17.3								
E-112	165	8.8								
E-112	175	13.4								
E-112	182	20.2								
E-112	185	17								
E-112	189.5	16.9								
E-112	192.5	13.1								
E-112	197.5	18.4						43.3	19.4	23.9
E-112	202	15.6								
E-112	212.5	16								
E-112	213.5	26.9								
E-112	215	22.8								
E-112	226	32.3								
E-112	232.5	31.3						70.9	28.4	42.5
E-112	256.5	30.4								
E-112	263.5	29.7								

Table 4: Summary of Index Testing Results (continued)

Boring Number	Top Depth (feet)	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)	% Gravel	% Sand	% Fines	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index PI
E-112	265	30.3						46.7	24.9	21.8
E-112	276	25.6								
E-112	284	27.8								
E-112	285	29.7								
E-112	288	26.6								
E-112	296	28.1								
E-113	28	6.9			4.6	58.6	36.9			
E-113	45	8			12.6	48.4	39.1			
E-113	72.5	7.1			14	53.8	32.3			
E-113	77	11.2					35.2			
E-113	99	9.2			16.3	59.2	24.6			
E-113	112	14.9								
E-113	121.5	16.9								
E-113	127	11.7								
E-113	132.5	19.2								
E-113	137	26.3								
E-113	188	16.1								
E-113	192	13.5						38.6	24.4	14.2
E-113	197	14.3						34.2	18.2	16
E-113	202	14.3								
E-113	207	13.5								
E-113	212	13.5								
E-113	217	15.7						30.3	18.3	12
E-113	220	14.2								
E-113	222	13.3								
E-113	225	15.3								
E-113	227	14.5								
E-113	230	14.3								
E-113	232	14.1								
E-113	236	14.3								
E-113	239	24.1						62.8	24	38.8
E-113	243	26.3								
E-113	248	13.7								
E-113	253.5	23.8								
E-113	255.5	24.7								
E-113	258	23.3						47	22.5	24.5
E-113	263	23.3								
E-113	269	23.8								
E-113	274	32.8						53.3	24.9	28.4
E-113	275	23.4								
E-114	60	17.4								
E-114	80	15.6								
E-114	100	21.3								

Table 4: Summary of Index Testing Results (continued)

Boring Number	Top Depth (feet)	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)	% Gravel	% Sand	% Fines	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index PI
E-114	120	16.6								
E-114	140	14.9					55.6			
E-114	145	19.2								
E-114	175	20.9					40.9			
E-114	185	16.8					4.8			
E-114	200	10.3	128.9	142.2				27.1	18.2	8.9
E-114	205	15.5								
E-114	210	13.1								
E-114	215	16.5								
E-114	220	11.7	122.1	136.5						
E-114	225	22.4								
E-114	230	20.5								
E-114	235	24.5						46.7	22	24.7
E-114	240	24.9								
E-114	260	17.2	109.5	128.3						
E-114	265	22								
E-114	270	24.9								
E-114	275	25.3								
E-114	280	16.4	109.9	128.0						
E-114	290	27.8								
E-114	300	41								
E-114	305	28.8						72.8	25.3	47.5
E-114	310	16	110.4	128.0						
E-114	315	20.3						64.3	24.8	39.5
E-114	322.5	23.6	89.5	110.6						
E-114	327	25.2								
E-114	332.5	19								
E-114	335	14.5								
E-114	337.5	19.6								
E-114	342.5	16.8								
E-114	345	13.2								
E-114	347.5	13.7								
E-114	350	17.9						29.3	17.1	12.2
E-114	357.5	17.1								
E-114	367.5	21.8					99.4			
E-114	372.5	19								
E-115	126.5	7.5			0	89.5	10.5			
E-115	213	22.9								
E-115	221	24.5						41.4	25.7	15.7
E-115	229	23.8								
E-115	233	35.5						53.7	32.3	21.4
E-115	246	29.4								
E-115	254	34.6						50.8	25.5	25.3

Table 4: Summary of Index Testing Results (continued)

Boring Number	Top Depth (feet)	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)	% Gravel	% Sand	% Fines	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index PI
E-115	259	25.4								
E-115	269	26						34.4	19.1	15.3
E-115	279	38.8								
E-115	284	24.7								
E-115	294	21.2								
E-115	300	26								
E-115	319	15.8			0	92.3	7.7			
E-115	394	6.8			26.3	66.1	7.6			
E-115	411	4.9			70.9	21.2	8			
E-115	434	7.2			43.6	43.3	13.1			
E-116	20	12.5			18.5	55.2	26.3			
E-116	37	12								
E-116	51.5	13.5								
E-116	70	15.6								
E-116	78	16.4								
E-116	90	27.7						63.4	26.5	36.9
E-116	100	19.2								
E-116	110	29.8								
E-116	120	19.2						39.1	21	18.1
E-116	130	18.6								
E-116	140	17.2								
E-116	155	21.5						55.7	22.9	32.8
E-116	162	33.1								
E-116	170	28.2						35	16.5	18.5
E-116	180	31.7						76.9	30.3	46.6
E-116	185	18.3								
E-116	196	18.5						56.1	21.6	34.5
E-116	207	30.3						59.3	28.4	30.9
E-116	230	27.4								
E-116	242	20.3			1.9	72.1	26			
E-116	260	19.9						31.2	22.1	9.1
E-116	268	20.1						25.6	20.5	5.1
E-117	183	6.1			38	52.9	9.2			
E-117	208	3.1			69.7	26.5	3.8			
E-117	228	29.3						36.3	26.3	10
E-117	258	8.1			12.9	38.8	48.3			
E-117	275	18.7			0	87	13			
E-117	306.5									
E-117	313	22.3						32.6	23	9.6
E-118	16.8	13.5								
E-118	22	18.4								
E-118	28	19								
E-118	38	22.9								

Table 4: Summary of Index Testing Results (continued)

Boring Number	Top Depth (feet)	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)	% Gravel	% Sand	% Fines	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index PI
E-118	40	21								
E-118	48	20.2								
E-118	55	9.5								
E-118	56.5	9.5						32.5	23.1	9.4
E-118	73.5	15.5			0.8	87.1	12.1			
E-118	83	15.6						43.9	24.8	19.1
E-118	95	21.4								
E-118	100	22.7						45.1	24.2	20.9
E-118	101	24.5						51	27.5	23.5
E-118	106.5	28.5						45.6	24.1	21.5
E-118	112	28.4						43.6	24.4	19.2
E-118	126	0.4			66.5	31.6	2			
E-118	138	10.7								
E-118	150	5.1			38.9	37	24.1			
E-118	153	9								
E-118	158	19								
E-118	161	9.1			27.9	48.7	23.5			
E-118	167.5	11.9			18.7	67.1	14.3			
E-118	170	15.6								
E-119	44	8.6			19.1	43.1	37.9			
E-119	65	10.1			5	36.3	58.7			
E-119	73.5	13.7			0.7	20.2	79.1			
E-119	76	11.9								
E-119	83	15.1								
E-119	93.5	10.5			8.3	38	53.8			
E-119	108	21.6								
E-119	113	20.5								
E-119	128	5.9			41.6	51.6	6.9			
E-120	10	10.1	121.5	133.8						
E-120	15	8.9	124.0	135.1						
E-120	20	11.6	121.9	136.0						
E-120	25	10.8								
E-120	30	10.6			17.6	64.8	17.5			
E-120	35	13.5								
E-120	40	15.1	110.8	127.5						
E-120	45	20.9								
E-120	50	23.6								
E-120	55	14.1	109.5	125.0						
E-120	60	18.5								
E-120	62.5	21.3								
E-120	65	18.9								
E-120	70	22.3			0.2	59.6	40.3			
E-120	75	21.4								

Table 4: Summary of Index Testing Results (continued)

Boring Number	Top Depth (feet)	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)	% Gravel	% Sand	% Fines	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index PI
E-120	80	11.1								
E-120	82.5	23.1								
E-120	87.5	20.6			1.4	84.7	13.9			
E-120	92.5	22.2								
E-120	97.5	20.1			0.5	84.2	15.3			
E-120	102.5	18.4			0.3	97.5	2.2			
E-120	107.5	5								
E-120	115	1.7								
E-120	117.5	8.7			42.6	53.4	4			
E-120	127.5	19								
E-120	132.5	24								
E-121	275	20.7					46.9			
E-121	282	25.1						60.2	30.7	29.5
E-121	299	28.6						53.5	24.2	29.3
E-122	118	19.7						45.7	19.8	25.9
E-122	128	20.7						49.8	20.8	29
E-122	131	22.5						46.8	20.2	26.6
E-122	136	21.9			0.2	96	3.8			
E-122	146	22						39.3	17.3	22
E-122	155	27.5						59.6	24	35.6
E-123	140	8.8			51.4	44	4.6			
E-123	230	13.5						40.6	18.2	22.4
E-123	265	17.8			0	86.6	13.4			
E-124	269	14.6			43.8	17.1	39.1			
E-124	279	10.2					29.5			
E-124	285	14			7.7	16.7	75.6			
E-124	295	20.4								
E-124	309	14.9						41.8	21	20.8
E-124	317	29.3						0	0	
E-124	326	19.8						30.6	16.4	14.2
E-124	337.5	14					43.8			
E-125	54	4.3			44.5	37.2	18.4			
E-125	60	7.4			30.2	43.1	26.8			
E-125	74	10.7			41	54.5	4.5			
E-125	79	7			52	37.9	10.2			
E-125	86	22.9						26.1	19.1	7
E-125	92	20.7					55.7			
E-125	110	18.4					98.3			
E-130	45	20.6								
E-130	65	24.4								
E-130	85	19.9								
E-130	100	22.5								
E-130	120	13.8								

Table 4: Summary of Index Testing Results (continued)

Boring Number	Top Depth (feet)	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)	% Gravel	% Sand	% Fines	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index PI
E-130	137.5	25.5								
E-130	140	32.7								
E-130	150	23.6								
E-130	155	21.6					6.6			
E-130	175	23.9								
E-130	195	21.4								
E-130	200	24.1					49			
E-130	205	25								
E-130	220	24.1								
E-130	230	15.3								
E-130	245	24.2								
E-130	250	25.8								
E-130	252.5	25.1								
E-130	255	24.4						44.2	22.8	21.4
E-130	265	25.7								
E-130	275	23.4						42.7	23.6	19.1
E-130	290.5	24.7								
E-130	295	22						37.7	20.4	17.3
N-151	47	23.4			0	97.9	2.2			
N-151	79	21.7			0	66.9	33.1			
N-151	88	23.6			0.1	49	50.9			
N-151	95	10.4			30.5	66.8	2.7			
N-152	10	13.7	119.1	135.4						
N-152	30	9.1	111.4	121.5						
N-152	50	2.4								
N-152	77	19.5						32	18.7	13.3
N-152	83	24								
N-152	95	25.6								
N-152	115	9.8								
N-153	11.5	9.9			40.2	56.1	3.7			
N-153	20	15.9								
N-153	25	20.3								
N-153	37.5	25.5			0	61.1	38.9			
N-153	42.5	25.3								
N-153	52.5	22.3								
N-153	57.5	5.5			62.6	36.4	1			
N-153	62.5	12			31.3	60.8	8			
N-153	77.5	3			0	53.3	46.7			
N-154	40	9			25.8	51.4	22.8			
N-154	50	6.3								
N-154	57.3	15			19.8	55.5	24.7			
N-154	70	7.4								
N-154	85	21.5			0	19.1	80.9			

Table 4: Summary of Index Testing Results (continued)

Boring Number	Top Depth (feet)	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)	% Gravel	% Sand	% Fines	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index PI
N-154	87.5	18.3			0	89.5	10.6			
N-154	105	19.6			0.4	91.9	7.8			
E-201	22	22.9								
E-201	27	26.3								
E-201	34	31.4								
E-201	38	21.6								
E-201	45	28.4								
E-201	53	35.9								
E-201	75	24.6								
E-201	94	22.5								
E-201	97	29.4								
E-201	105	34.7								
E-201	119	24								
E-201	192	17.3								
E-201	195	56								
E-201	199	22.7								
E-201	202	22.5								
E-201	208	26.3								
E-201	216	21.3								
E-203	140	21.5	100.3	121.9						
E-203	160	18.8	101.1	120.4						
E-203	180	17.3	106.9	125.4						
E-203	202	51								
E-203	210	28								
E-203	220	36.4								
E-203	230	27.8								
E-203	240	27.2								
E-215	235				27.7	47.9	24.4			
E-215	235.5	8.8								
E-215	240	21						48.5	23.8	24.7
E-215	244	19.9								
E-215	249	25.4								
E-215	256	17.3								
E-215	263	16.8								
E-215	267	17.3								
E-215	271	20.8								
E-215	278	22.2								
E-215	282	21.1					67.9			
E-215	283	23.3								
E-215	288	20.6								
E-215	291	26.4						49.8	26.2	23.6
E-215	292	25.9								
E-215	298	21.9								

Table 4: Summary of Index Testing Results (continued)

Boring Number	Top Depth (feet)	Water Content (%)	Dry Density (pcf)	Wet Density (pcf)	% Gravel	% Sand	% Fines	Liquid Limit, LL	Plastic Limit, PL	Plasticity Index PI
E-215	303	16.8								
E-215	306	30.4								
E-215	310	32.8						59.9	31.8	28.1
E-215	311	28.4								
E-215	316	33.9								
E-215	324	29.8								
E-215	327	32.7								
E-215	331	31.8								
E-215	335	29.4						48.8	26.8	22
E-215	339	34.3								
E-215	342	34.3								
E-215	345	30.3								
E-215	351	28.5								
E-215	357	27.4								
E-216	188	24.4								
E-216	190	35.8								
E-216	196	41.6								
E-216	255	26.1								
E-216	303	24.7								
E-216	310	26.5								
E-216	315	21								
E-216	323	24.1								
E-216	335	25.1								
E-217	56	24.9								
E-217	96	28.6								
E-217	116	37.4								
E-217	236	25.1								

Table 5: Summary of Unconfined Compressive Strength Testing

Boring Number	Sample Depth (feet BGS)	Unconfined Compressive Strength (psf)	Strain at Failure (%)	Failure Plane Angle (Degrees from Horizontal)
E-110	260	11,531	3.11	50
E-112	232.5	4,650	2.3	37
E-112	265	5,529	5.3	70/75
E-114	235	15,983	7.6	55
E-114	315	9,256	14.9	60
E-114	352.5	10,701	7.4	75
E-114	367.5	2,640	3.4	70
E-118	101	9,704	5.19	85
E-130	195	3,021	6.1	70
E-130	205	6,453	5.7	NR
E-130	255	11,602	10.2	70
E-130	275	11,978	9.2	65
E-130	290.5	1,609	4.6	46/72
E-223	200.0	9,400	3.14	65
E-223	200.5	4,775	2.84	80
E-322	286.4	11,302	1.7	80
E-322	287.4	18,791	3.0	80
E-322	288.2	21,881	2.6	80

Table 6: Summary of Gas Monitoring Data

Boring Number	Date	Time	Boring Depth (ft)	Casing Depth (ft)	Top of Screen Depth	Bottom of Screen Depth (ft)	Sample Type	Methane (%)	CO (%)	O_2 (%)	H_2S (ppm)
E-101	05/06/2003	NR	140	0	121	131	Standpipe	0.1	NR	NR	NR
E-101	05/20/2003	NR	140	0	121	131	Standpipe	0.1	NR	NR	NR
E-102	05/06/2003	NR	270	0	185	195	Standpipe	0.1	NR	NR	NR
E-102	05/20/2003	NR	270	0	185	195	Standpipe	0.2	NR	NR	NR
E-103	05/06/2003	NR	380	0	320	340	Standpipe	0.1	NR	NR	NR
E-103	05/20/2003	NR	380	0	320	340	Standpipe	0.1	NR	NR	NR
E-106	05/06/2003	NR	566	0	419	429	Standpipe	0.0	NR	NR	NR
E-106	05/20/2003	NR	566	0	419	429	Standpipe	0.2	NR	NR	NR
E-110	04/22/2003	NR	438	0	190	200	Standpipe	0.1	NR	NR	NR
E-110	05/06/2003	NR	438	0	190	200	Standpipe	0.2	NR	NR	NR
E-110	05/20/2003	NR	438	0	190	200	Standpipe	0.2	NR	NR	NR
E-111	04/22/2003	NR	385	0	343	353	Standpipe	0.1	NR	NR	NR
E-111	05/06/2003	NR	385	0	343	353	Standpipe	0.2	NR	NR	NR
E-111	05/20/2003	NR	385	0	343	353	Standpipe	0.2	NR	NR	NR
E-114	04/22/2003	NR	374	0	180	190	Standpipe	2.6	NR	NR	NR
E-114	05/06/2003	NR	374	0	180	190	Standpipe	2.2	NR	NR	NR
E-114	05/20/2003	NR	374	0	180	190	Standpipe	0.2	NR	NR	NR
E-116	04/22/2003	NR	305	0	233.5	243.5	Standpipe	0.1	NR	NR	NR
E-116	05/06/2003	NR	305	0	233.5	243.5	Standpipe	0.1	NR	NR	NR
E-116	05/20/2003	NR	305	0	233.5	243.5	Standpipe	0.1	NR	NR	NR
E-117	04/22/2003	NR	341	0	272.5	282.5	Standpipe	0.1	NR	NR	NR
E-117	05/06/2003	NR	341	0	272.5	282.5	Standpipe	0.1	NR	NR	NR
E-121	04/22/2003	NR	329	0	271	281	Standpipe	0.2	NR	NR	NR
E-121	05/06/2003	NR	329	0	271	281	Standpipe	0.0	NR	NR	NR
E-121	05/20/2003	NR	329	0	271	281	Standpipe	0.1	NR	NR	NR
E-123	05/20/2003	NR	286	0	116	126	Standpipe	0.2	NR	NR	NR

Table 6: Summary of Gas Monitoring Data (continued)

Boring Number	Date	Time	Boring Depth (ft)	Casing Depth (ft)	Top of Screen Depth	Bottom of Screen Depth (ft)	Sample Type	Methane (%)	CO (%)	O_2 (%)	H_2S (ppm)
E-126	04/22/2003	NR	86	0	20	126	Standpipe	0.2	NR	NR	NR
E-126	05/06/2003	NR	86	0	20	126	Standpipe	0.0	NR	NR	NR
E-126	05/20/2003	NR	86	0	20	126	Standpipe	0.2	NR	NR	NR
E-129	04/22/2003	NR	335	0	275	285	Standpipe	0.1	NR	NR	NR
E-129	05/06/2003	NR	335	0	275	285	Standpipe	0.1	NR	NR	NR
E-129	05/20/2003	NR	335	0	275	285	Standpipe	0.2	NR	NR	NR
E-201	05/20/2003	NR	242	0	225	235	Standpipe	0.1	NR	NR	NR
E-202	05/20/2003	NR	361	0	330	340	Standpipe	0.1	NR	NR	NR
E-203	05/06/2003	NR	360	0	123	133	Standpipe	0.0	NR	NR	NR
E-203	05/20/2003	NR	360	0	123	133	Standpipe	0.2	NR	NR	NR
E-206	05/20/2003	NR	493	0	396	406	Standpipe	0.2	NR	NR	NR
E-208	05/20/2003	NR	425	0	242	252	Standpipe	0.2	NR	NR	NR
E-216	04/22/2003	NR	338	0	212	222	Standpipe	0.1	NR	NR	NR
E-216	05/06/2003	NR	338	0	212	222	Standpipe	0.1	NR	NR	NR
E-216	05/20/2003	NR	338	0	212	222	Standpipe	0.1	NR	NR	NR
E-217	05/06/2003	NR	310	0	280	290	Standpipe	0.1	NR	NR	NR
E-217	05/20/2003	NR	310	0	280	290	Standpipe	0.1	NR	NR	NR
E-219	05/20/2003	NR	320	0	229	239	Standpipe	0.1	NR	NR	NR
E-220	05/20/2003	NR	290	0	233	243	Standpipe	0.2	NR	NR	NR
E-311	06/04/2003	15:28	20	20	No Well	No Well	Bag/Soil	0	0	0	0
E-311	06/04/2003	15:33	59.3	59.3	No Well	No Well	Casing Break	0.1	0	19.6	0
E-311	06/04/2003	15:57	64.3	64.3	No Well	No Well	Casing Break	0.25	0	0	0
E-311	06/04/2003	15:59	64.3	64.3	No Well	No Well	Casing Break	0	0	0	0
E-311	06/05/2003	10:45	102.1		No Well	No Well	?	0	0	20.8	0
E-311	06/05/2003	10:45	102.1		No Well	No Well	?	0	0	20.9	0
E-311	06/05/2003	11:30	112.1		No Well	No Well	?	0	0	20.8	0

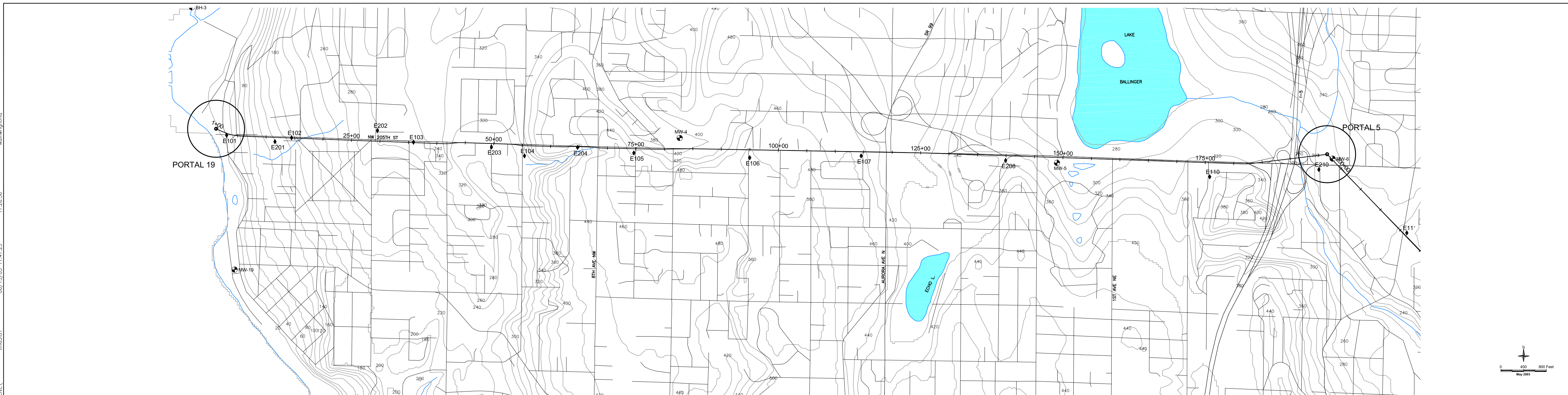
Table 6: Summary of Gas Monitoring Data (continued)

Boring Number	Date	Time	Boring Depth (ft)	Casing Depth (ft)	Top of Screen Depth	Bottom of Screen Depth (ft)	Sample Type	Methane (%)	CO (%)	O_2 (%)	H_2S (ppm)
E-311	06/05/2003	12:32	66.1	63.6	No Well	No Well	Casing Break	0.75	0	19.6	0
E-311	06/05/2003	12:38	66.1	63.6	No Well	No Well	Casing Break	0.3	0	20.6	0
E-311	06/05/2003	13:18	67.1	63.6	No Well	No Well	Casing Break	0	0	20.7	0
E-311	06/05/2003	13:20	117.1		No Well	No Well	?	0	0	20.8	0
E-311	06/05/2003	13:57	67.1	63.6	No Well	No Well	Casing Break	0.4	0	0	0
E-311	06/05/2003	14:42	72.1	63.6	No Well	No Well	?	0	0	0	0
E-311	06/05/2003	14:42	72.1	63.6	No Well	No Well	?	1.25	0	0	0
E-311	06/05/2003	15:25	92.1		No Well	No Well	Bagged Sample	0	0	20.8	0
E-311	06/05/2003	15:25	119.3		No Well	No Well	Bagged Sample	0	0	20.8	0
E-311	06/06/2003	7:40	77.1	63.6	No Well	No Well	Tedlar Bag	0.4	0	19.8	0
E-311	06/06/2003	8:04	77.1	63.6	No Well	No Well	Casing Break	0	0	19.4	0
E-311	06/06/2003	8:04	77.1	63.6	No Well	No Well	Casing Break	0.3	0	NR	0
E-311	06/06/2003	8:04	77.1	63.6	No Well	No Well	Casing Break	2.25	0	19.2	0
E-311	06/06/2003	8:04	77.1	63.6	No Well	No Well	Casing Break	2	0	0	0
E-311	06/06/2003	8:28	82.1	63.6	No Well	No Well	Casing Break	0	0	20.8	0
E-311	06/06/2003	8:28	82.1	63.6	No Well	No Well	Casing Break	0	0	20.6	0
E-311	06/06/2003	9:02	87.1	63.6	No Well	No Well	Casing Break	0	0	0	0
E-311	06/06/2003	9:02	87.1	63.6	No Well	No Well	Casing Break	0	0	0	0
E-343	05/20/2003	NR	180	0	59	69	?	0.3			
E-349	05/20/2003	NR	200	0	65	75	?	0.2			
E-362	05/20/2003	NR	105	0	80	90	?	0.1			
N-153	05/06/2003	NR	89.5	0	79	89	?	0.0			

NOTES:

NR - Not read

a) Assumes methane LEL equal to 5% methane by volume



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Data Sources: CDM

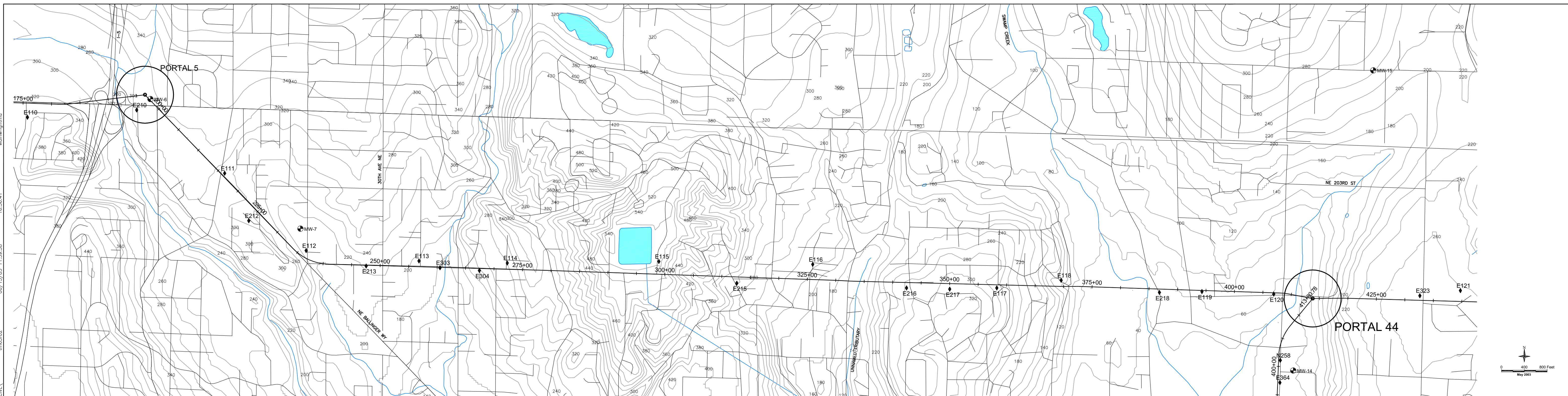
File Name: plan800a.dwg

Figure 1

Effluent Alignment Plan (Part 1)

BRIGHTWATER REGIONAL
WASTEWATER TREATMENT SYSTEM

P:\19897\37576\CIVL\ tm65f01 06/13/03 11:47:23 17:26:56 Wainwrightmd



Data Sources: CDM

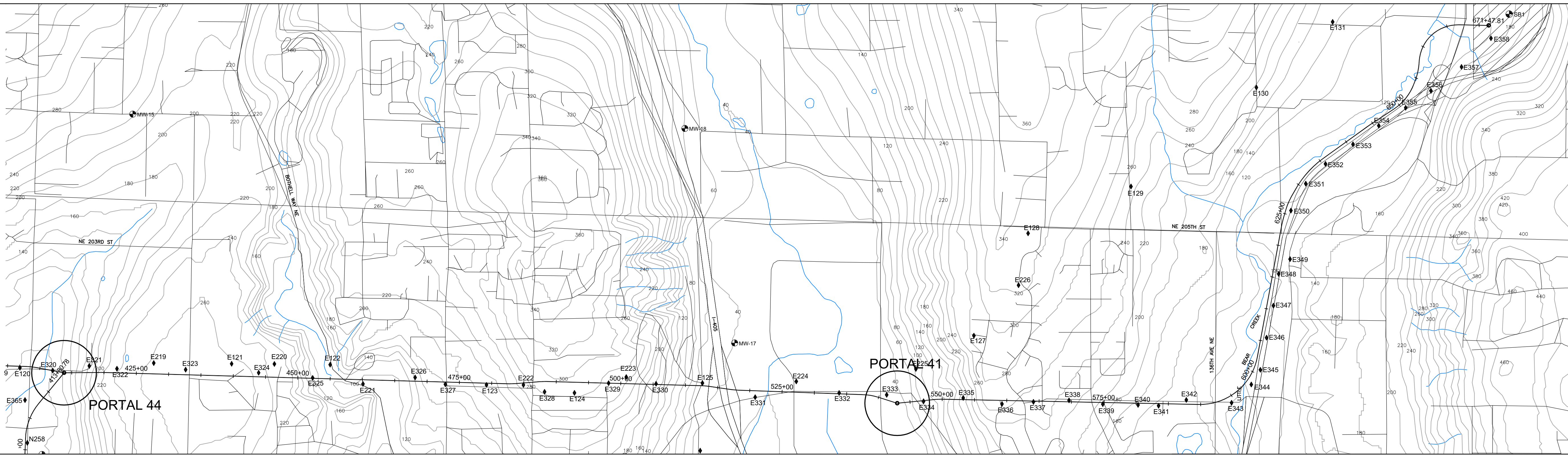
File Name: prof800a.dwg

P:\19897\37576\CIVIL\ tm65002 06/13/03 11:59:38 16:56:41 Wainwrightmd

Figure 2

Effluent Alignment Plan (Part 2)

BRIGHTWATER REGIONAL
WASTEWATER TREATMENT SYSTEM



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Data Sources: CDM

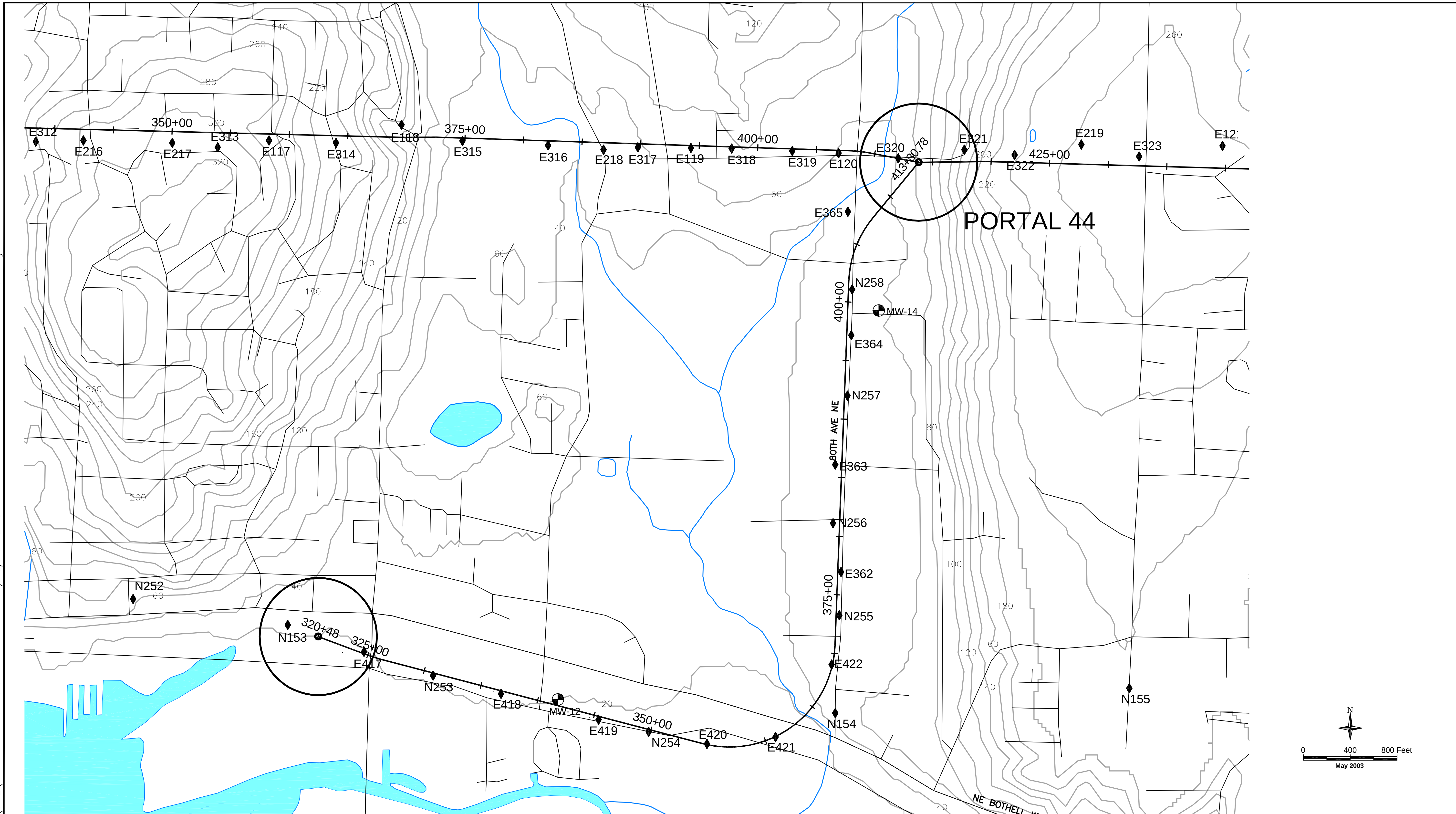
File Name: plan800d.dwg

Figure 3

Combined Alignment Plan

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

P:\19897\37576\CIVL\ plan800d 06/03/03 15:20:29 16:54:35 Wainwrightmd



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Data Sources: CDM

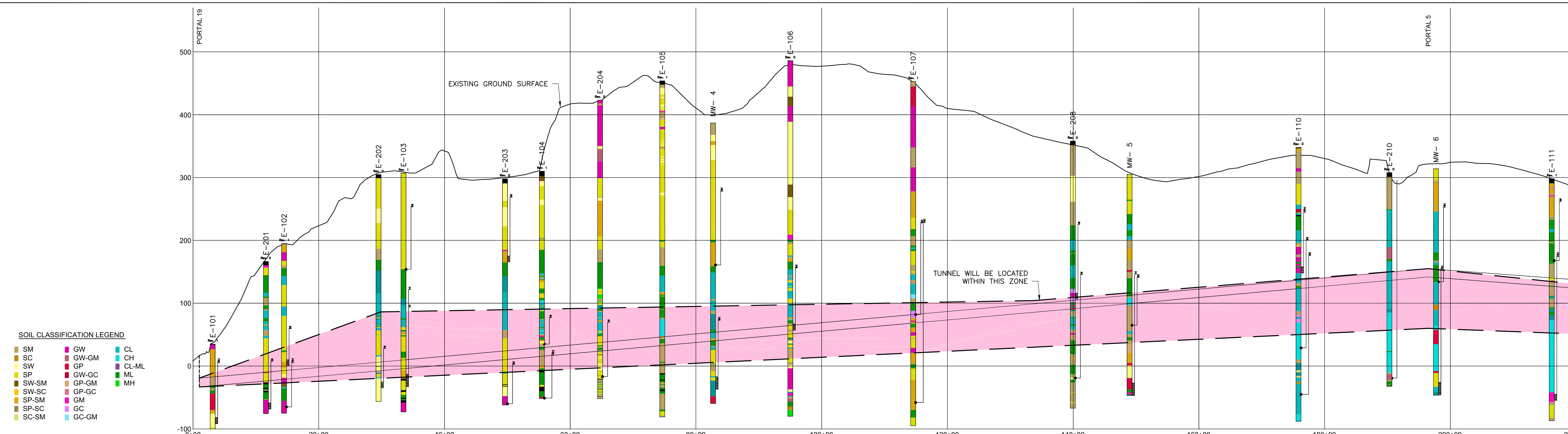
File Name: plan800a.dwg

Figure 4

Influent Alignment Plan

BRIGHTWATER REGIONAL
WASTEWATER TREATMENT SYSTEM

P:\19897\37576\CIVL\ tm65f04 06/13/03 12:18:44 17:04:50 Wainwrightmd



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Data Sources: CDM

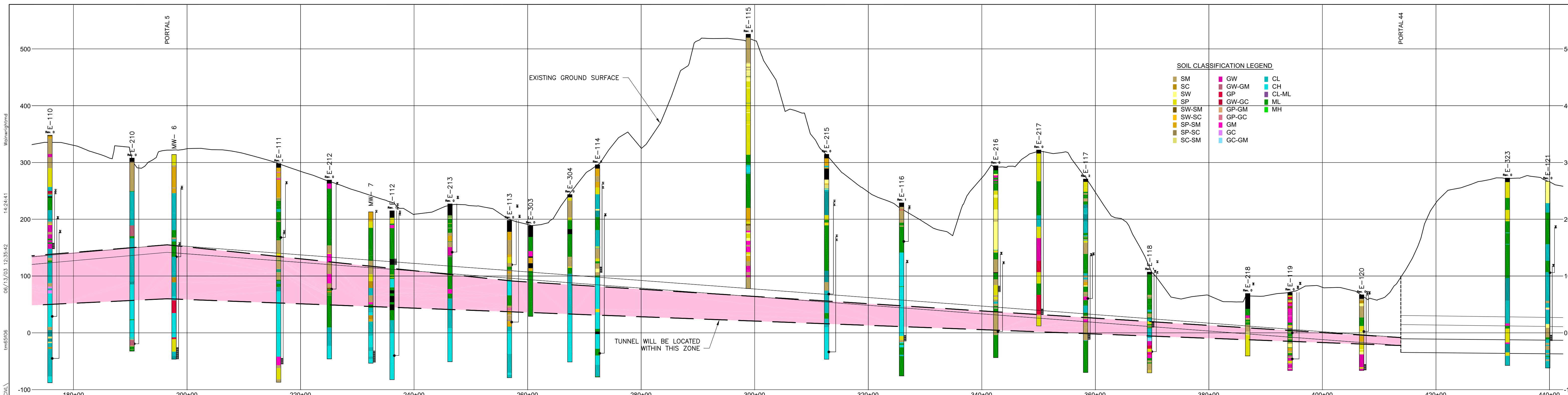
File Name: prof800a.dwg

Figure 5

Effluent Alignment Subsurface Profile (Part 1)

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

P:\19897\37576\CIVL\ tm65i05 06/13/03 12:32:20 16:47:16 Wainwrightmd



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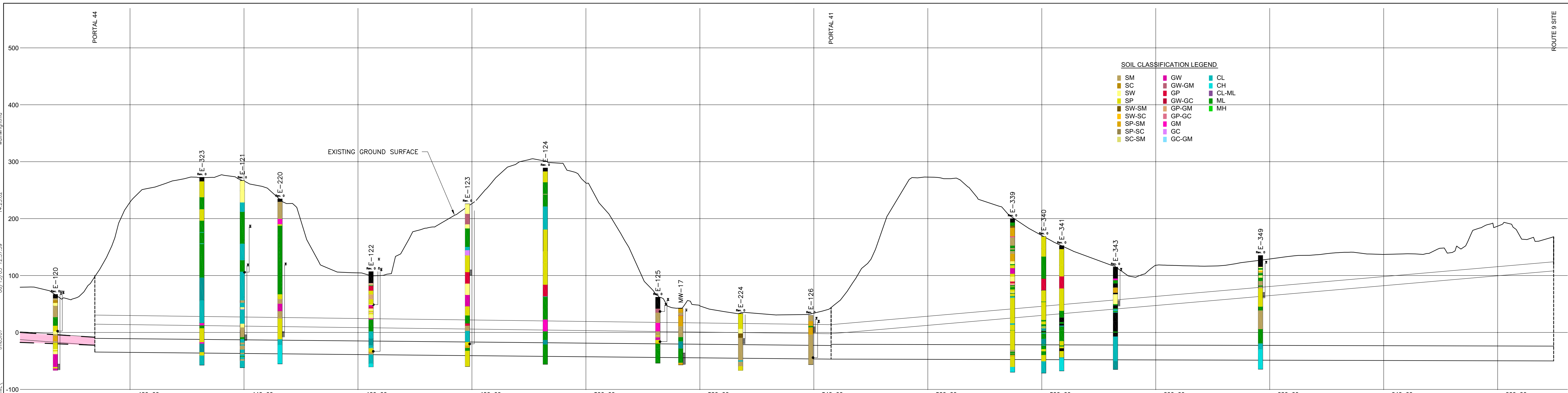
File Name: prof800a.dwg

Figure 6

Effluent Alignment Subsurface Profile (Part 2)

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

P:\19897\37576\CIVL\ tm65106 06/13/03 12:35:42 14:24:41 Wainwrightmd



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Data Sources: CDM

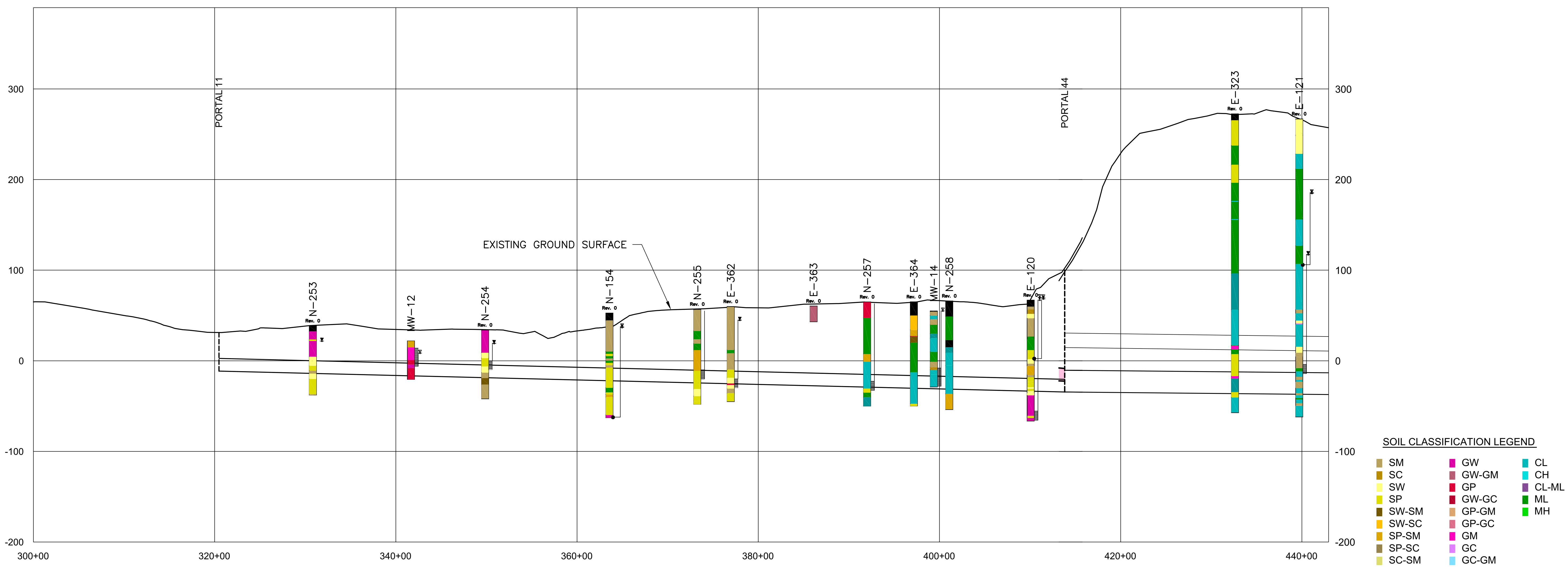
File Name: prof800a.dwg

P:\19897\37576\CIVL\ tm65r07 06/13/03 12:37:39 14:25:02 Wainwrightmd

Figure 7

Combined Alignment Subsurface Profile

BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM



Wainwrightmd 14:39:56 06/13/03 12:55:56 tm65108 P:\19897\37576\CIVL\

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Data Sources: CDM

File Name: prof800a.dwg

Figure 8
Influent Alignment Subsurface Profile
BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES (Excluding particles over 3 inches and basing fractions on estimated weight)						Symbol Text	Symbol Graph
Coarse-Grained Soils More than 50% retained on No. 200 Sieve	**Gravel** More than 50% retanited on No. 4 Sieve	**Clean Gravel** Less than 5% Fines	Well-Graded Gravel, Gravel-Sand Mixtures with little or no fines			GW	
			Poorly-Graded Gravel, Gravel-Sand Mixtures with little or no fines			GP	
		Gravel with Fines More than 12% Fines	Silty Gravel, Gravel-Sand-Silt Mixtures (non-plastic or silty fines as determined below)			GM	
			Clayey Gravel, Gravel-Sand-Clay Mixtures (plastic or clayey fines as determined below)			GC	
	Sand More than 50% passing No. 4 Sieve	**Clean Sand** Less than 5% Fines	Well-Graded Sand, Gravelly Sands with little or no fines			SW	
			Poorly-Graded Sand, Gravelly Sands with little or no fines			SP	
		Sand with Fines More than 12% Fines	Silty Sand, Gravel-Sand-Silt Mixtures (non-plastic or silty fines as determined below)			SM	
			Clayey Sand, Gravel-Sand-Clay Mixtures (plastic or clayey fines as determined below)			SC	
Fine-Grained Soils More than 50% passing No. 200 Sieve			**Dry Strength**	**Dilatancy**	**Toughness**		
	Silts and Clays	Liquid Limit less than 50 (OL if >30% organics by volume)	None to Low	Slow to Rapid	None	ML	
			Medium to High	None to Slow	Medium	CL	
			Low to Medium	Slow	Low	OL	
		Liquid Limit greater than 50 (OH if >30% organics by volume)	Low to Medium	None to Slow	Low to Medium	MH	
			High to Very High	None	High	CH	
			Medium to High	None to Very Slow	Low to Medium	OH	
Highly Organic Soils (>50% Organics)			Readily identified by color, odor, spongy feel, frequently with fibrous texture			PT	

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Figure 9
Soil Classification System
BRIGHTWATER REGIONAL WASTEWATER TREATMENT SYSTEM